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INCLUDING PRESTRESSED CONCRETE

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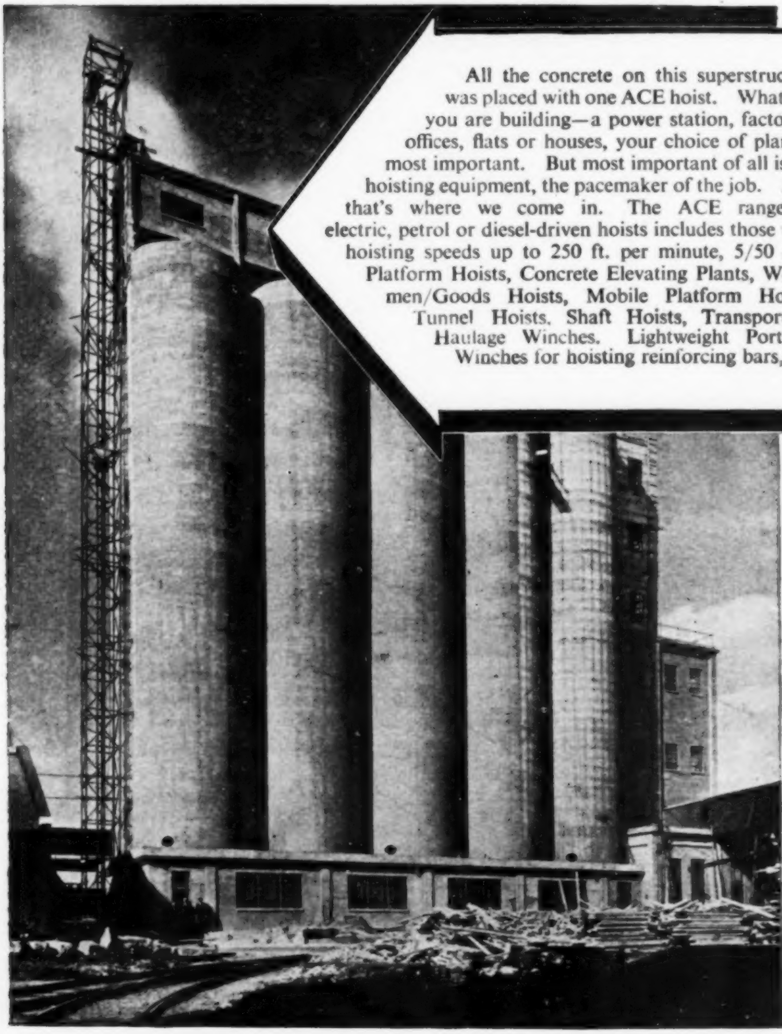

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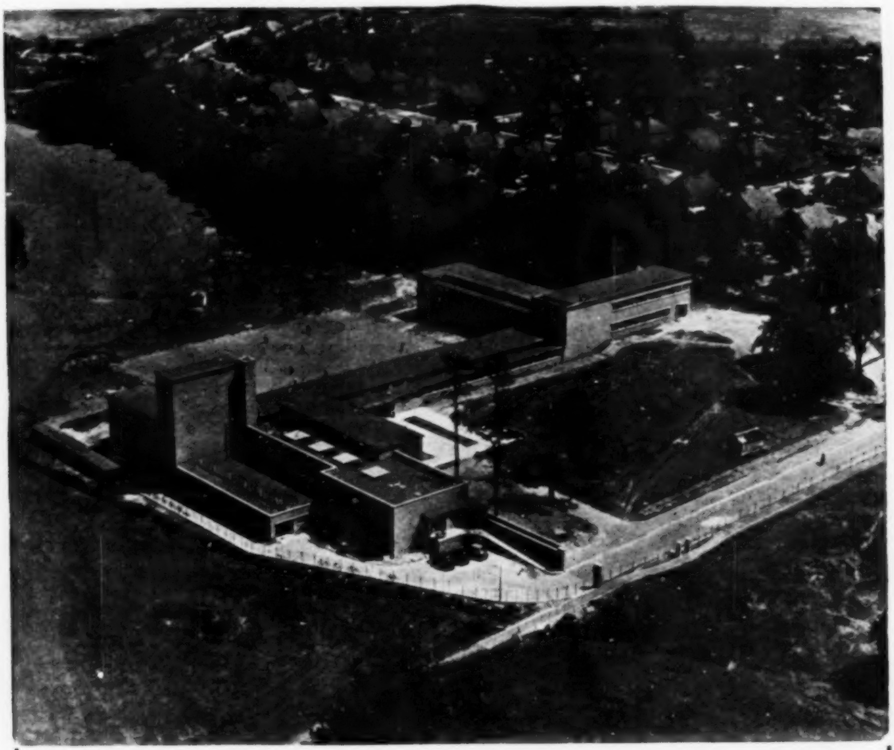


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CONCRETE AND CONSTRUCTIONAL ENGINEERING

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Volume XLVII. No. 4. LONDON, APRIL, 1952.

EDITORIAL NOTES

The Setting and Hardening of Cement and Concrete.

In many countries for many years much research has been undertaken on the setting and hardening of Portland cement, but the reasons for these phenomena are still not generally agreed. A new theory was put forward by M. E. Freyssinet at the congress on prestressed concrete held in Belgium in September last which, in the opinion of Professor Gustave Magnel, is in harmony with the known phenomena of the deformation of concrete under different types of load and with changes of temperature and humidity, and which also explains the high early strengths that result from compressing and heating concrete at an early age. Briefly, M. Freyssinet's theory is that concrete is a complex of solid, liquid, and vapour phases which are continually interchanging due to the influences of external pressure and changes of temperature and moisture content, and that the laws of thermodynamics are applicable to concrete.

According to this theory the mixing water dissolves slightly the grains of cement. Saline ions are dispersed in the liquid and, where the solution is sufficiently rich, they form with the molecules of water relatively stable hydrated crystals. The largest crystals are less soluble and tend to absorb the smallest, and also to retard the formation of small crystals by reducing the concentration of the solution. On the other hand, a crystal can grow if ions reach its surface by passing through the liquid by channels which are more restricted and sinuous as the number of crystals increases, so that the ions may become grouped into new crystals were the solution is sufficiently concentrated, the crystals forming a close mesh, the interstices of which contain water. The average size of the crystals will be smaller as the circulation of the ions becomes slower. Therefore the number and size of the crystals depend on the rate of circulation of the ions in the paste during setting, and circulation is made more difficult by compression of the paste and reduction in the amount of water. Setting is accelerated as the temperature is raised, but the structure of the set paste is coarser because of the formation of large crystals, and the strength is less. If, however, the size of the crystals can be reduced by compressing the paste, it is possible to apply heat of 100 deg. C. or more and still have great strength.

It can be demonstrated, states M. Freyssinet, that plastic extension results in a decrease of the pressure in the interstitial liquid, and therefore a reduction in

the solubility of the hydrates. By enlarging the channels, movement of the ions is favoured and there is a resumption of the process of the formation of the hydrates ; this is not conjecture, since new cracks in concrete can be healed if the fissure is narrow and a humid condition is maintained. On the contrary, great compression subjects the interstitial liquid to compression, and causes the solution of some of the hydrates. These actions affect the ratio of the resistance to compression to the resistance to tension of concrete. Not only plastic deformation, but all deformations of concrete depend, according to this theory, on the properties of the spaces in the mesh formed by the hydrated crystals.

In explaining the behaviour of concrete, M. Freyssinet states that compression within the elastic range causes a sliding or shearing action on the mortar between pieces of coarse aggregate, resulting in fracture of some of the cementitious hydrates. The resistance of the concrete is not altered even if the compression is applied repeatedly, and therefore broken crystals must be replaced instantly by others. All deformations bring into play the mechanism of setting, that is the process of autogenous healing. The deformations are, however, due to inequalities, and are caused when the applied forces exceed the passive resistances. When movement commences the balance is upset and the passive resistances suddenly decrease, so that instead of a continuous and reversible deformation, like an elastic deformation, there is a series of irreversible deformations alternating with halts in the movement.

When concrete dries it does so first at the surface ; the interior loses its water only slowly and tends to retain its original length. Hence large tensile stresses occur at the surface causing it to stretch. When the drying reaches the interior, the stretched surface compels the interior to stretch. If, therefore, a free block of concrete undergoes cycles of wetting and drying (or thermal variations) there are produced as many small elongations as cycles. If concrete is compressed sufficiently, however, it ceases to elongate and appears to shorten. The factors comprising the deformation of concrete subjected to compression are stated as follows. First, there are in unloaded concrete initial deformations which depend on the curing and which are difficult to estimate. On application of the load there is immediately a reversible elastic deformation followed by a deferred elastic deformation the magnitude of which is only a fraction of the first elastic deformation and is masked temporarily by the re-establishment of the hygrometric state of the concrete. There is also a plastic deformation which is the ordinary very slow process of crystallisation and dissociation of the hydrates which constitute the mechanism of setting. The applied load increases the probability of the occurrence of those phenomena which result in a decrease in volume, and the effect known as creep is produced. Some investigators consider that the whole of the deferred deformation is non-reversible creep, but M. Freyssinet is of the opinion that it is the sum of a creep (that is the tendency of a system towards maximum stability and regarding the reversibility of which the author has no knowledge) and a deferred elastic deformation (deferred by the wetting of the concrete due to pressure) and which is entirely reversible.

Water-cooling Structures at an Oil Refinery.

FEATURES of the water-cooling system at the new refinery for the Shell Petroleum Co., Ltd., at Stanlow, Cheshire, include reinforced concrete culverts (some of which are designed to resist high pressures), travelling steel shutters used in the construction of the culverts, bridges where a road, pipe-duct, and the culverts pass under railways (*Figs.* 1 to 3), and the cooling tower. The joint consulting engineers are Messrs. Maunsell, Posford & Pavry, and Sir Alexander Gibb & Partners. The general contractors are Messrs. A. Monk & Co., Ltd., and the contractors for the cooling tower, which was designed by Messrs. L. G. Mouchel & Partners, Ltd., are Messrs. Fred Mitchell & Son, Ltd.

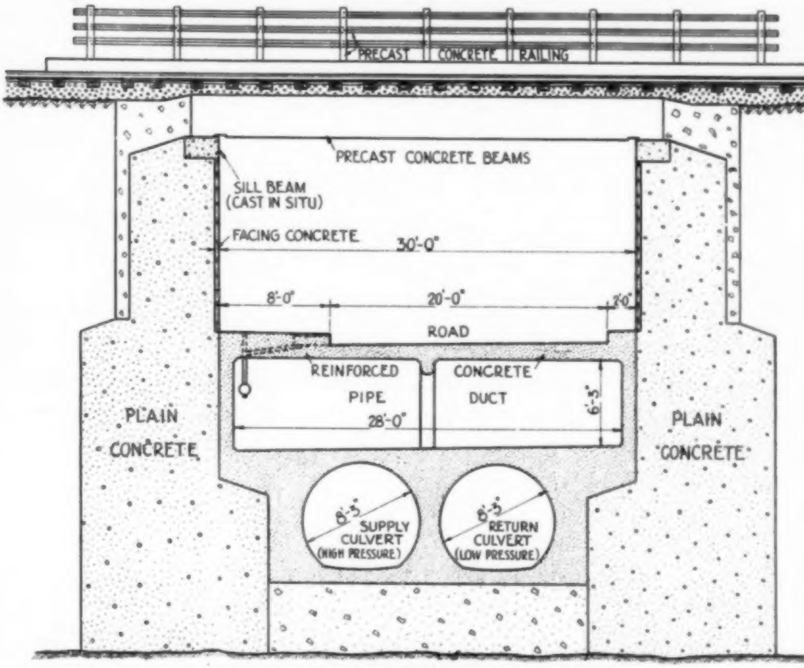
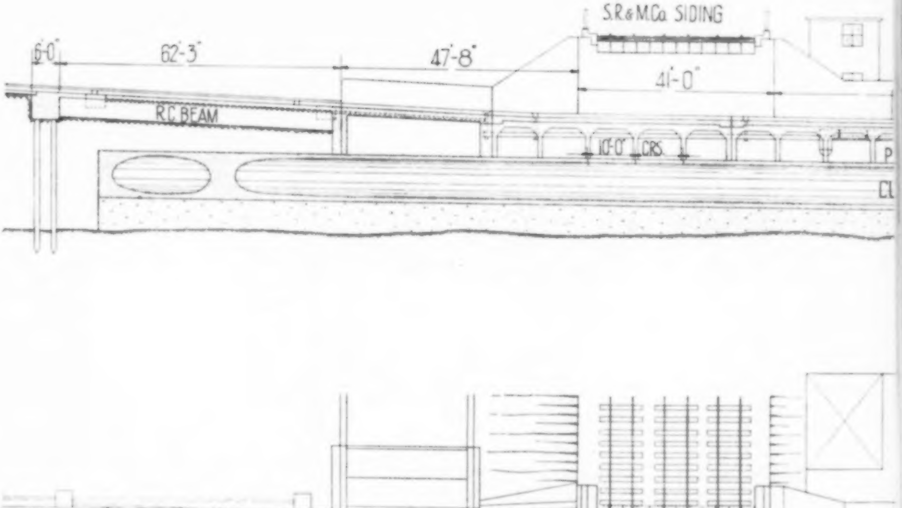


Fig. 1.—Cross Section of Underpass.

Culverts.

The water is pumped from the Manchester Ship Canal and conducted under a hill through a concrete-lined tunnel 3000 ft. long. The tunnel was driven through sandstone from both ends and from two headings from a shaft 75 ft. deep which now forms part of the surge tower. From the tunnel to the oil-processing works the water flows through a reinforced concrete culvert which is of horse-shoe section 8 ft. 3 in. diameter (*Figs.* 4 and 5) for a distance of 4100 ft., and of octagonal section 8 ft. wide (*Fig.* 6) for a distance of 2000 ft. The supply and return culverts are alongside each other and are contained in a single block of reinforced concrete. The block is founded on plain concrete where the rock is near the bottom of the culverts, and elsewhere on cast-in-situ piles, 30 ft. to 40 ft. long, each capable of carrying a load of 40 tons. At the oil-processing plant the water is conducted through smaller culverts and precast concrete pipes (*Fig.* 7) to the various parts of the plant. The heated

Fig. 2.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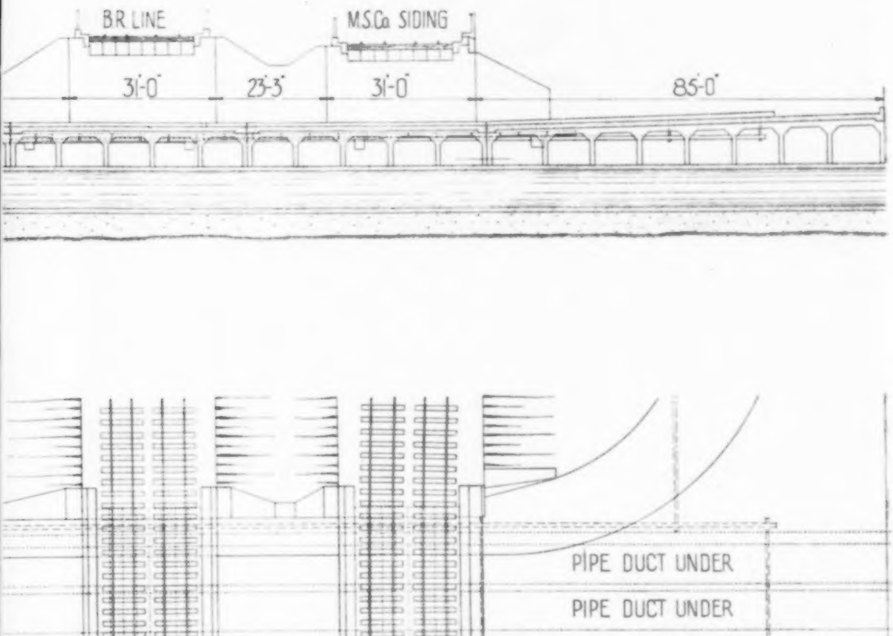
62'-3"
47'-8"
41'-0"
R.C. BEAM
10'-0" CRS.
FOOTPATH
ROAD
PIPE DUCT

Fig. 3.—Pl

water is then passed to the cooling tower, where it is partially cooled (*Fig.* 12), and from which it flows through the low-pressure return culverts to oil-interceptors (shown in course of construction in *Fig.* 9), and thence by an open channel which discharges the cooled water over a spillway into the canal. The quantity of water which will be dealt with eventually will be about 161,000,000 gallons daily.

The culverts were constructed mainly in open sheet-piled trenches. Construction joints (*Fig.* 4) are provided at intervals of 20 ft., and are sealed by a perforated strip of copper which crosses the joint. The sections between joints were concreted alternately. The face of the concrete on one side of the joint was roughened thoroughly before new concrete was placed against it. Where the culverts are at a lower level to pass under the railways (*Fig.* 1), the pressure in the supply culvert is due to 120 ft. head of water, that is 52 lb. per square inch. The greatest pressure in the return culvert is due to about 30 ft. head of water. The circumferential tension is resisted entirely by the ring reinforcement, the tensile stress in which does not exceed 12,000 lb. per square inch. The concrete is a high-grade 1 : 2 : 4 mixture.



Underpass.

Travelling Shuttering.

The invert of the culverts was concreted in advance of the walls and roof. Travelling shutters were used for the construction of the sides and roof of the circular and octagonal culverts (*Figs.* 6, 10, 11). The shutters for the circular culverts were designed by Acrow (Engineers), Ltd., and were in units each 10 ft. 6 in. long. Each unit comprised steel plates supported on three rectangular transverse steel frames mounted on a carriage carried on four wheels running on a track on the invert (*Fig.* 11). The plates were in three lengths of 3 ft. 6 in. longitudinally and in three circumferential sections, namely two side sections and one roof section which was pivoted on hinges on the side sections. The roof section was supported at the crown on longitudinal walings and could be raised or lowered by the operation of screw jacks on the transoms of the frames. Each side-plate was connected to the vertical members of the main frames by tie-rods, the lengths of which were adjusted by turnbuckles. *Fig.* 11 shows a longitudinal section of a shutter for the circular culvert, and a cross section of this shutter in the working position; in *Fig.* 10 the shutter is shown in the retracted position for travelling. Generally the time taken to fix a shutter, place the concrete, retract the shutter after the concrete had hardened sufficiently, and move it forward 10 ft. ready for fixing in the next position was such that 60 ft. of culvert were constructed each week.

Fig. 4.—Construction Joint in Circular Culverts.

Railway Bridges.

The three parallel bridges (*Figs.* 1 to 3) carry respectively a three-track siding of the oil company, a double-track passenger and goods line of British Railways, and a double-track siding of the Manchester Ship Canal Co. They are designed for British standard loadings for standard-

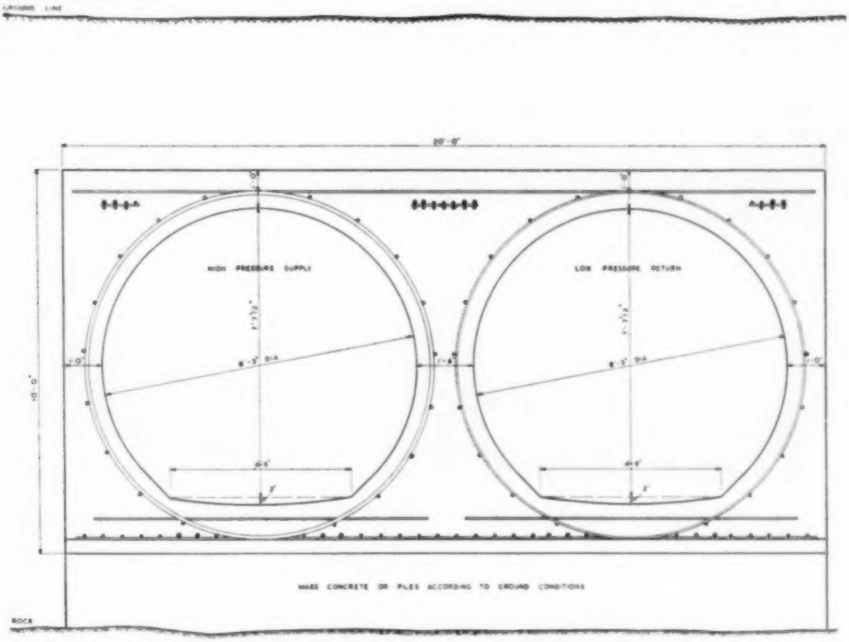


Fig. 5.—Cross Section of Reinforced Concrete Culverts.

Fig. 6.—Shuttering and Reinforcement for Octagonal Culverts.

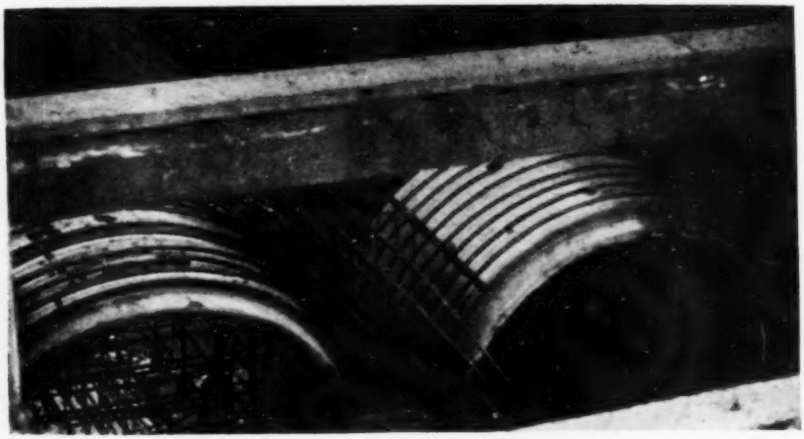


Fig. 7.—Reinforcement around Precast Pipe Culverts.

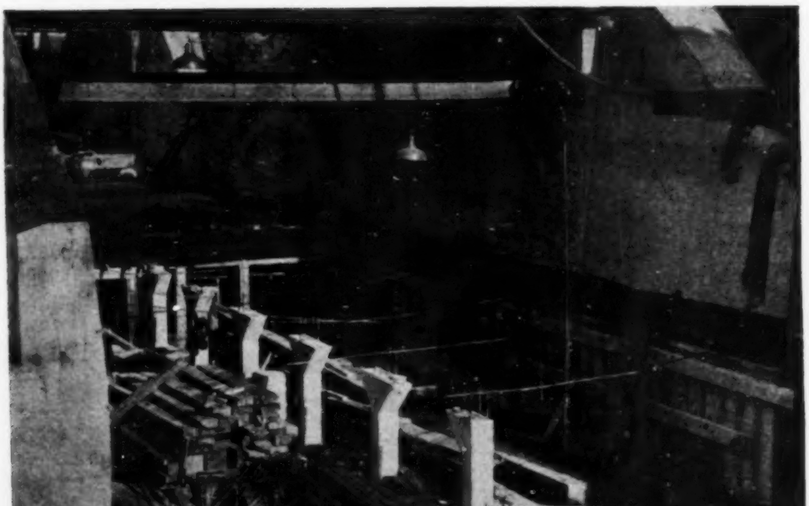


Fig. 8.—Construction of Pipe Duct under Bridges.

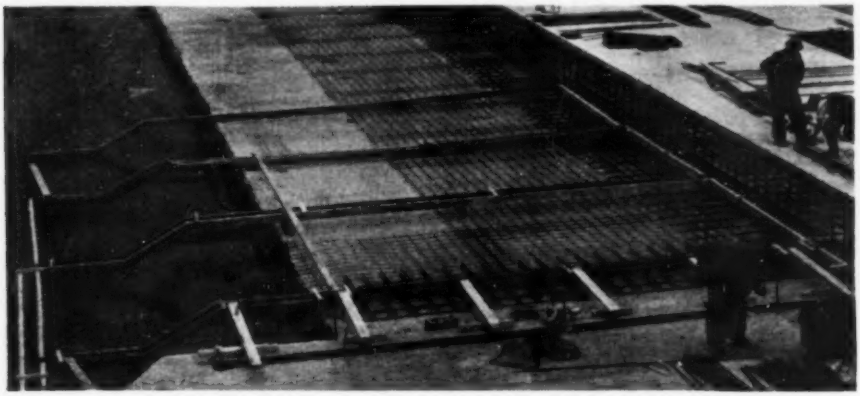


Fig. 9.—Reinforcement and Screeds for Oil Interceptors.

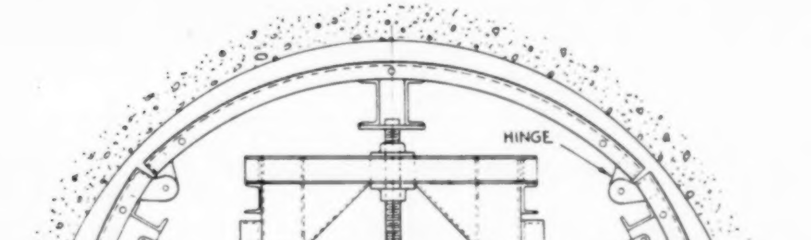


Fig. 10.—Tunnel Shutter Ready for Moving.

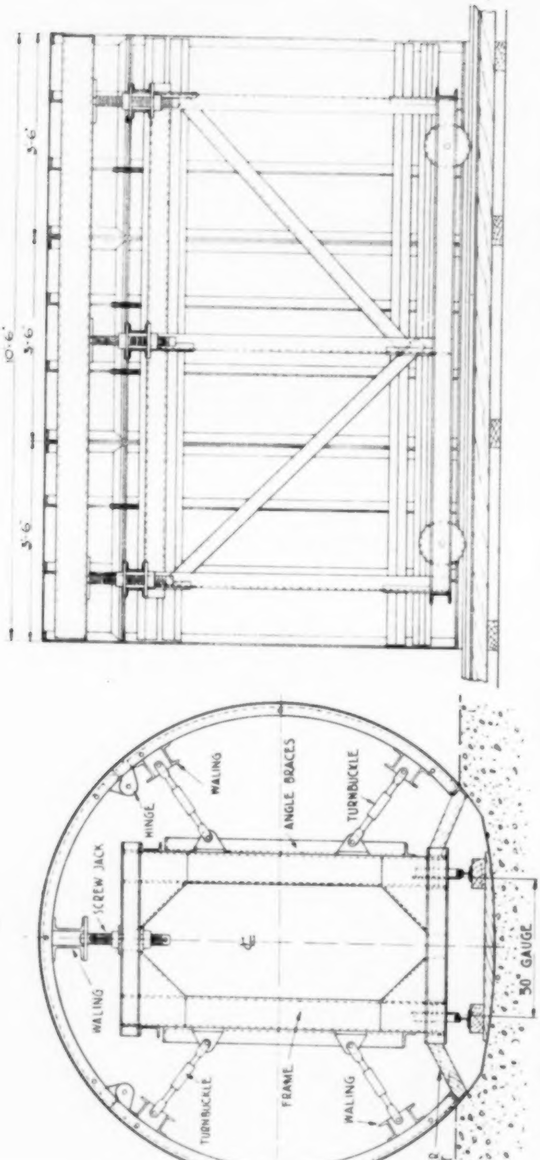


Fig. 11.—Cross Section and Longitudinal Section of Tunnel Shutter ready for Concreting.

Fig. 12.—Cooling Tower, 342 ft. high.

gauge railway girder bridges (B.S. No. 153), the bridges for the sidings being designed for 15-units load and for the main line 20-units load. The deck of each bridge, the clear span of which is 30 ft., is constructed with precast beams of a standard design of British Railways. The beams are of rectangular cross section 33½ in. wide and 30 in. deep in the bridges for the sidings and 36 in. deep for the more heavily loaded bridge. They are reinforced with five 1¼-in. bars and four 1½-in. bars, and bear on sills of high-grade concrete. A transverse chase in the underside at each end prevents the beam bearing on the corner of the sill, which otherwise might spall. The sill-beams were cast-in-situ on plain concrete abutments, the exposed faces of which are of richer concrete placed by the aid of a sliding plate.

The precast beams are laid closely together and the ballast laid directly on them. The small gaps between the beams are made watertight by being partly filled with a joint filler after having been plugged with hemp. The joint is covered by 2½-in. by 6-in. by ¾-in. concrete tiles set in rebates along the tops of the beams. The beams, each of which weighs up to 20 tons, were erected by a railway crane, two 1-in. diameter lifting eyes being embedded at 19-ft. centres in the top of each beam.

Below the bridge there is a cast-in-situ reinforced concrete pipe-duct of 6 ft. 3 in. minimum depth and 28 ft. wide. The top

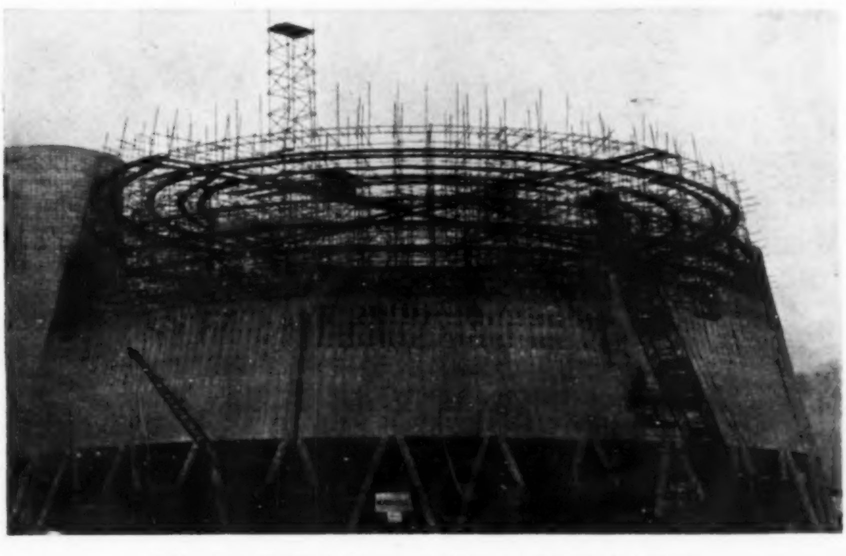


Fig. 13.—Cooling Tower in Course of Construction.

slab of the duct forms a road and footpath (*Fig.* 1). The road slab is designed for the standard load of the Ministry of Transport, the maximum stresses in the reinforcement and concrete being 18,000 lb. and 750 lb. per square inch respectively. The slab is supported at the ends on the walls of the duct and intermediately on a longitudinal beam carried on columns (*Fig.* 8). The floor of the duct is formed by the top of the reinforced concrete block of the low-level twin culverts already described.

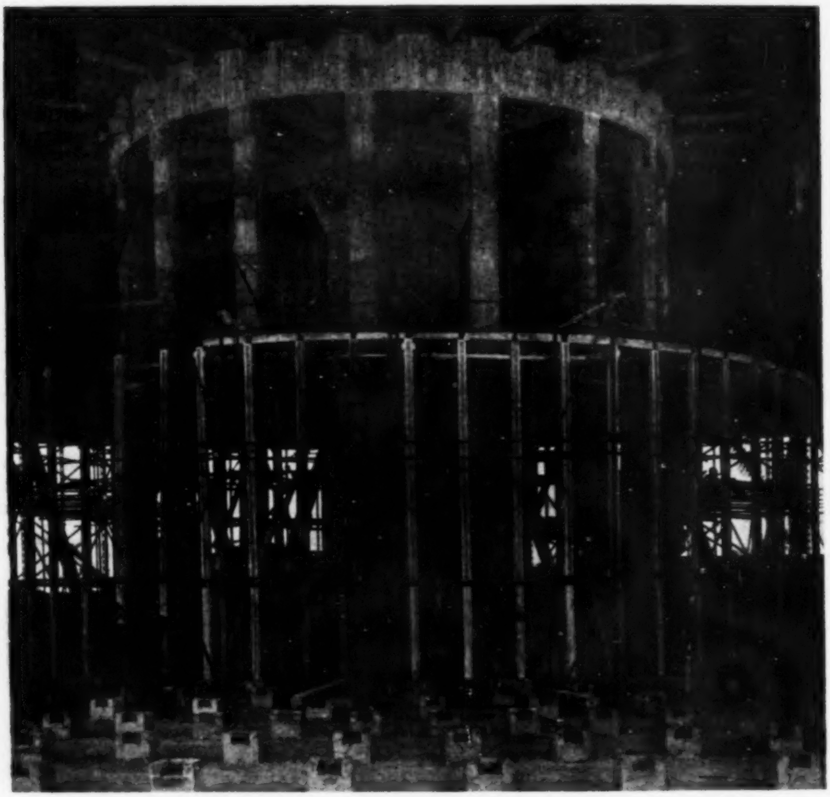


Fig. 14.—Cooling Tower: Precast Concrete Posts and Sole Pieces for Cooling Stack.

Cooling Tower.

The cooling tower (*Figs.* 12 and 13) which, as stated in this journal for August 1951, is the largest in the world, is 341 ft. 6 in. high and 260 ft. diameter at the base. It is founded on sandstone. The annular apron around the top of the pond at ground level is split at the point where each pair of diagonal columns meet so that it can expand and contract with some degree of freedom. The cooling stack (*Figs.* 14 and 15) inside the tower is of precast concrete members, a method of construction that has been used successfully in other towers since 1941. It is 40 ft. high and comprises 1120 columns, 29,376 bearers and rings, and diagonal struts. The members were erected progressively in rings from the centre of the tower and, as seen in *Fig.* 14, the stack

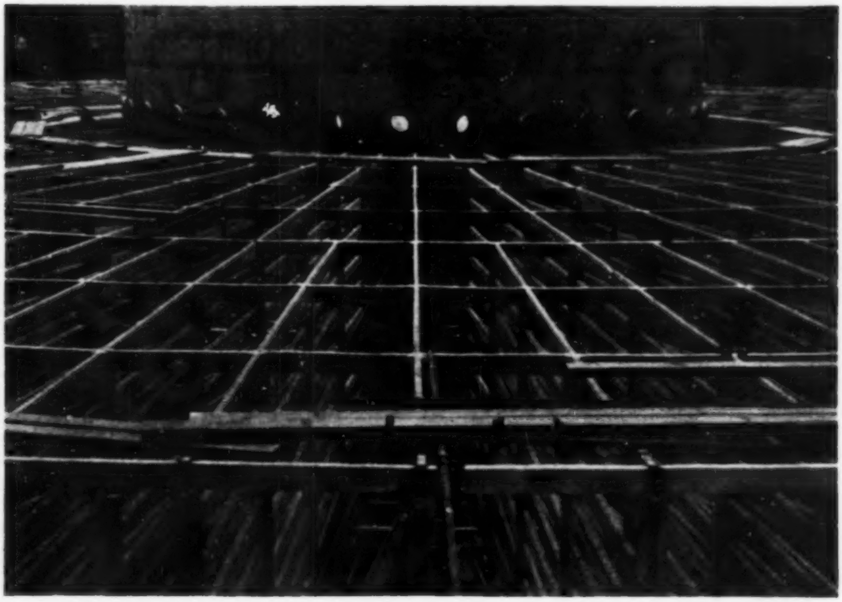


Fig. 15.—Cooling Tower: Precast Concrete Cooling Stack.

was erected in two lifts. Wooden laths are placed across the horizontal members in the serrations seen in *Fig.* 15. The dimensions of the cross sections of the concrete members are small, but the greatest stresses were those produced during the transport of the members from the factory in Leicestershire to the site. The stresses under working conditions are considerably less. The proportions of the concrete are 7 cwt. of cement, 13½ cu. ft. of sand, and 27 cu. ft. of coarse aggregate. The castings were vibrated on a table and the concrete had a crushing strength of not less than 5000 lb. per square inch at seven days. The precast concrete members were made by the Croft Granite, Brick & Concrete Co., Ltd.

Reinforced Concrete Regulations in Germany.

THE fourth edition of the German reinforced concrete regulations* includes codes of practice, standard specifications, recommendations, and memoranda related to concrete practice, and design tables for hollow-tile floors. Permissible compressive stresses in concrete vary from 570 lb. to 1710 lb. per square inch depending on the quality. The tensile stress permitted in the reinforcement varies from 17,100 lb. to 34,200 lb. per square inch depending on the quality of the steel. The modular ratio is assumed generally to be 15 but, in calculations of statically-indeterminate structures and elastic deformation, the elastic modulus of concrete is assumed to be 3,000,000 lb. per square inch in compression or tension. The moment of inertia of a member is determined for the full concrete section with and without ten times the area of the reinforcement.

* "Bestimmungen des Deutschen Ausschusses für Stahlbeton." (Berlin: Wilhelm Ernst & Sohn. 1951. Price 6.50 D.M.)

Book Reviews.

"Earth Retaining Structures." Civil Engineering Code of Practice No. 2. 1951. (London: Institution of Structural Engineers. Price 15s.)

THIS code, which is also in the nature of a text book, will be of direct interest to all concerned with the design of civil engineering works, and is likely to be worth its cost to students. It has been prepared by a joint committee of the Institution of Civil Engineers, the Institution of Water Engineers, the Institution of Municipal Engineers, and the Institution of Structural Engineers. The compilers are to be congratulated on the very valuable summaries of recommended practice in the design of a range of structures including retaining walls (both gravity and reinforced), sheet-piled walls, cribwork, revetments, and sea-walls. The code may seem needlessly verbose to engineers experienced in the design of earth-retaining structures, but for others the recitation of the requirements of good design for each type of structure is probably not superfluous, for failures have often been the result of ignoring the obvious. Nevertheless the number of illustrated examples of failures, although very well presented, seems somewhat out of place, especially as they are nearly all well known and taken from readily-available literature. This type of information is not necessary in a document called a code of practice, and the result is to produce a publication of 224 pages of information which is sound and useful to the student even if most of it is not new to experienced engineers. —D. L.

"The Displacement Method of Frame Analysis." By G. P. Manning. (London: Concrete Publications, Ltd. 1952. Price 9s.)

IN the displacement method of analysing indeterminate structures, the bending moments and shearing forces are expressed in terms of arbitrarily imposed unknown rotations and displacements of the joints and the known stiffness factors and effects of the load. By simple self-checking tabulation, the expressions for the moments and shears can be written down readily. The condition of equilibrium of the joints gives the necessary simultaneous equations, the solution of which gives the actual values of the rotation and displacements in general terms; the substitution of these values in the expressions for the moments and shears gives directly the magnitude of these actions. The convention of algebraic signs is simple and is allied to line-diagrams of the frames showing the assumed deformation; the actual deformation is determined from the results of the calculations. The arithmetical solutions can be obtained generally with sufficient accuracy by the use of a slide rule.

The method is applicable to continuous beams and frames of any shape whether subjected to sway or not. Examples are given of bridges, culverts, sheds, substructures of bunkers, buildings, and the like. Examples are given to show the effect of including or neglecting the variable moment of inertia of the members. Tables give factors for members of constant section, members with straight or curved haunches, parabolic soffits, or uniform taper, and members comprising two or three parts each of constant section.

Although the solution of several simultaneous equations is necessary, a procedure which requires as little effort as is practicable and by which errors are less likely to occur is explained. The fact that frame calculations are generally made in the drawing office is kept to the front throughout this eminently practical work by an engineer of long and wide experience who has proved the value of the method in practice for some years.

"Pipe Resistance." By T. E. Beacham. 1952. (London: E. & F. N. Spon, Ltd. Price 18s.)

DESCRIBES a method of estimating the resistance of pipes to the flow of oils, spirits, and other non-aqueous liquids. A series of diagrams gives the resistances of pipes under a wide range of conditions, and from these it is possible to select the most economical size of pipe for a particular purpose.

"Testing of Measuring Equipment." A National Bureau of Standards Handbook. (Washington, U.S.A.: Government Printing Office. 1951. Price 1·25 dollars.)

THIS is a handbook issued for the guidance of inspectors of weights and measures in the United States of America. It gives descriptions of commercial measures and measuring devices, with recommendations for their inspection and testing.

A Prestressed Concrete Footbridge at Shrewsbury.

THE footbridge across the river Severn at Shrewsbury (*Fig.* 1) is built on the Freyssinet system, and the tender was accepted in competition with tenders for carrying out the work in structural steel and reinforced concrete.

The bridge comprises two sets of three cantilever beams 45 ft. long pivoting on 3½-in. diameter steel rollers on the original bridge piers, which are at 150 ft. centres. Four precast beams 60 ft. long rest on 2½-in. diameter steel rollers and rocker bearings at the ends over the river of the cantilever beams. The overall length of the bridge is 247 ft., and the width 11 ft. 6 in. The deck is formed of precast slabs 3 in. thick. At the piers the beams are 7 ft. deep and at the centre of the suspended span 2 ft. 9 in. deep. The soffit of the span has a rise of 7 in. in 150 ft. The bridge is designed for a live load of 100 lb. per square foot plus an additional dead load of 18 lb. per square foot for services.

The end cantilever beams are 8 in. wide and the cantilevers over the river 16 in. Each set is stiffened with cross-beams at 9 ft. centres at the top and at 3 ft. centres at the bottom. A flange 4 in. wide at the top of the beams carries the deck slabs. The suspended beams are of channel section with webs 6½ in. thick, stiffened at 9 ft. centres with vertical ribs. The flanges of these beams

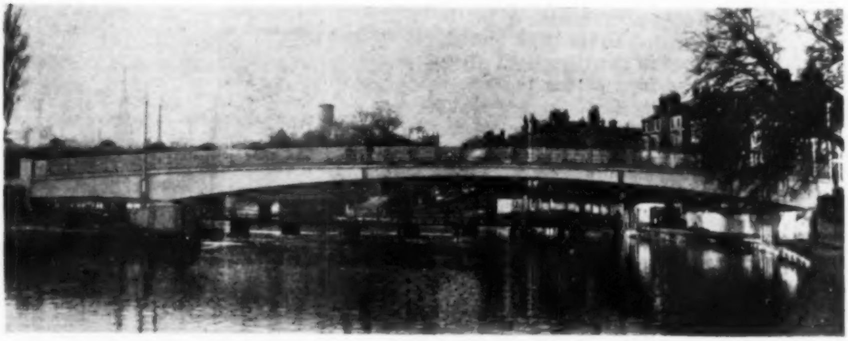


Fig. 1.

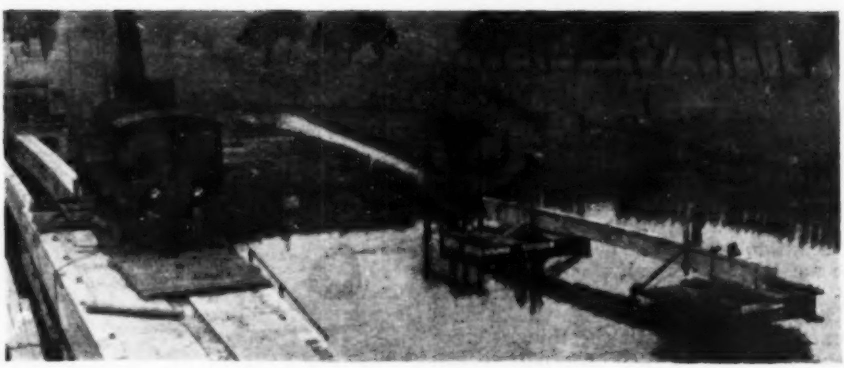


Fig. 2.—Transporting a Beam.

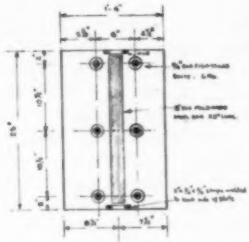
are 12 in. wide (one-sixtieth of the span). After erection these beams were connected together at the top with an in situ reinforced concrete beam. Precast beams at 3 ft. centres are freely supported between the bottom flanges. For all the main beams, precast end blocks containing Freyssinet cones are used. The counterweight for each cantilever span weighs 66 tons, and is provided by a block of concrete 13 ft. square in plan in the bank; a pin-joint is provided at the base of the counterweight.

The mass concrete piers of the towers of the old suspension bridge were demolished to the required height and on them were laid reinforced concrete caps and the bearing plate for the steel roller.

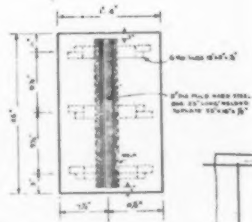
The river bed at the site is generally 10 ft. to 16 ft. below low water level. To support the cantilever beams projecting over the river, twenty-four 9-in. by 9-in. timber piles were driven about 9 ft. into the river bed. Timber posts, 9 in. by 9 in., were fish-plated to the piles and the staging was braced in two directions above water level. The tops of the posts were capped with 9-in. by 6-in. timbers which cantilevered over each side of the staging to serve as supports for a walkway, and 6-in. by 3-in. steel channels from the old bridge supported the centering. The cantilever beams were cast in situ on the staging.

The central suspended beams 60 ft. long were cast on the bank about 100 ft. upstream. A cutting was excavated in the river bank at right-angles to the river, and on the formation, which sloped towards the river, was laid a concrete slab which served as a slipway down which the beams were moved on 4-in. diameter steel rollers to a timber piled gantry at the water's edge where the beams were placed on pontoons. The pontoons supporting each end of the beam were floated downstream to the lifting position (*Fig.* 2). Two 5-tons mobile cranes travelled to the ends of the cantilever beams, which were still supported by the staging, and lifted the beams, which weighed about 9½ tons each, into position. The erection of each beam took about half a day.

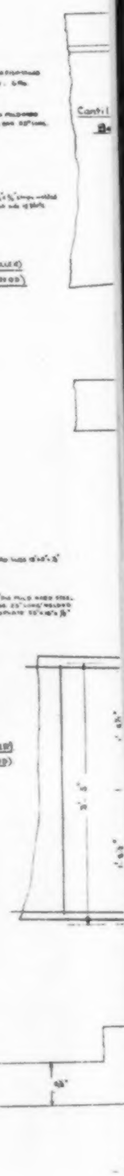
Each prestressing cable comprises twelve 0·2 in. diameter high-tensile wires encased in soft plastic sheathing. There are six cables in each suspended beam,

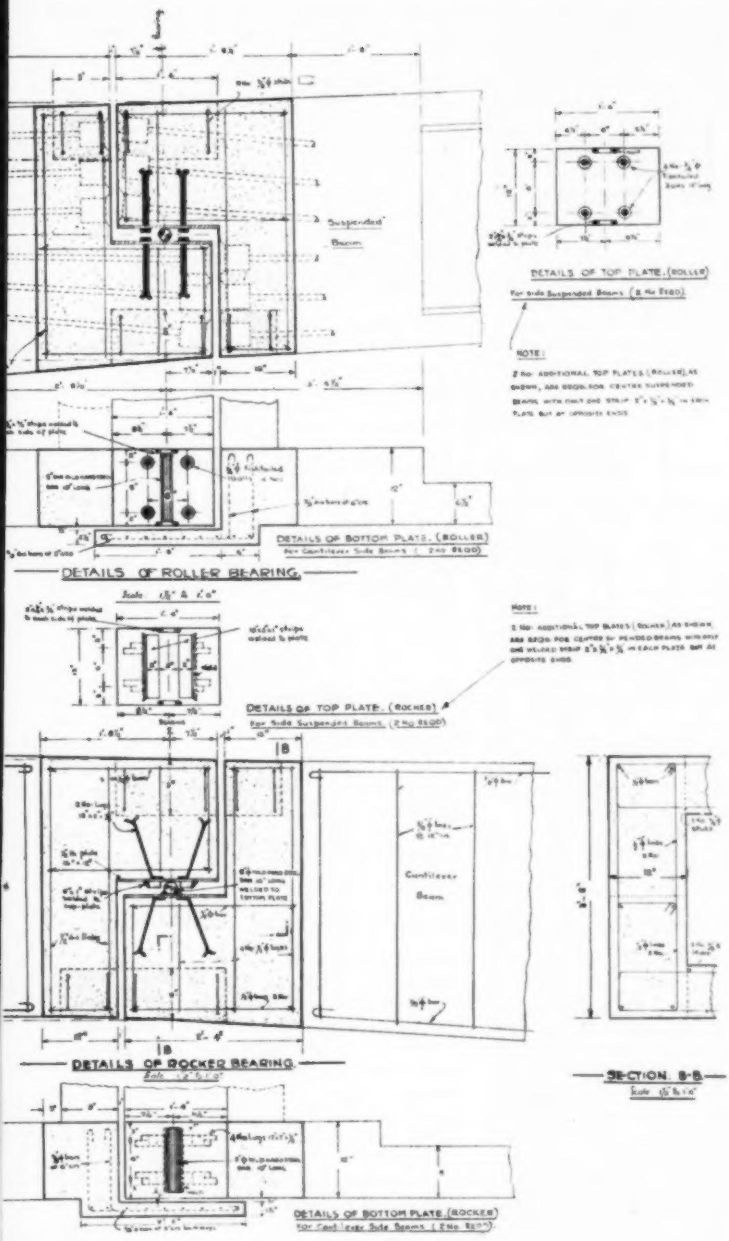


DETAILS OF BOTTOM PLATE (ROLLER) For Cantilever Centre Beam (1 No. reqd)



DETAILS OF BOTTOM PLATE (ROCKER) for Cantilever Centre Beam (1 No. reqd)





.—Details of Roller and Rocker Bearings.

Fig. 4.—Elevation.

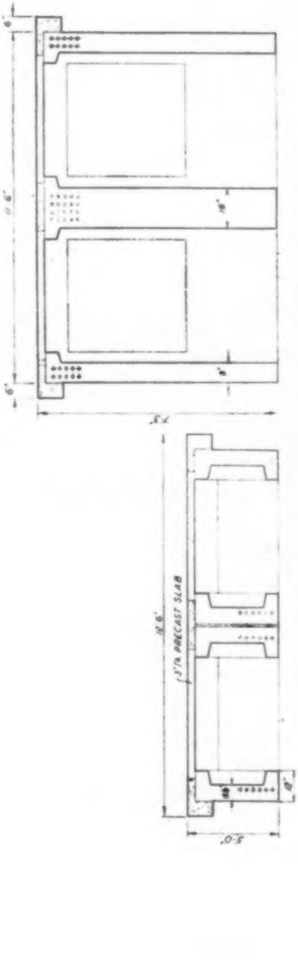


Fig. 5.—Cross Section at Midspan (left) and Pier (right).

twenty cables in each cantilever beam over the river, and ten cables in each beam on the landward side of the abutments. The cables were tensioned by a jack at each end. When the wires were tensioned the ends of the cantilever beams over the river lifted $\frac{5}{16}$ in., and the 60 ft. suspended girders lifted $\frac{3}{8}$ in. at the middle. The cables were grouted with neat cement, which was mixed with water in a colloidal mixer. An elevation and sections are given in *Figs.* 4 and 5, and details of the rocker and roller bearings are in *Fig.* 3.

The concrete mixture used in the reinforced concrete work was in the proportions of 1 : 2 : 4, and 1 : 1·3 : 2·6 in the case of the prestressed concrete. Rapid-hardening cement was used and the aggregate was $\frac{3}{4}$ in. maximum size. The water-cement ratio was 0·45. All concrete was vibrated in position by pencil-type vibrators. Six-inch cubes were tested at 7, 14, and 28 days, and had compressive strengths of 4870 lb., 5760 lb., and 6450 lb. per square inch respectively. The wires were tensioned when the concrete had a strength of 6000 lb. per square inch.

Mr. F. R. Dinnis is the Borough Surveyor. The consulting architects were Messrs. T. P. Bennett & Son, the consulting engineers Messrs. L. G. Mouchel & Partners, Ltd., and the Pre-stressed Concrete Co., Ltd., and the contractors were Taylor Woodrow Construction, Ltd.

"Concrete and Constructional Engineering" Prize Design.

THE subject set for the year 1950–1951 for the "Concrete and Constructional Engineering" prize of £25, which is awarded each year for competition among the post-graduate students of reinforced concrete technology at the City and Guilds College of the Imperial College of Science and Technology, London, was the industrial development of a site on the river Thames between Lambeth bridge and Wandsworth bridge. The development was to include a single-story warehouse with a suspended floor, a 20-story garage, a jetty, a water tower, and two road bridges. Fifteen students, working in four groups, submitted designs.

The assessor was Mr. F. E. Wentworth-Sheilds, O.B.E., Past-president of the Institution of Civil Engineers. In the course of his report, the assessor states that he was impressed by the good work done by the candidates and by their mastery of engineering construction in reinforced concrete and prestressed concrete. Among so many good designs it had not been easy to choose the best, but he recommended that the prize be awarded to Mr. J. Langdon for his design for a 20-story garage, and gave honourable mention to Mr. W. W. L. Chan for his design for a water tower.

The competition was set and supervised by Professor A. L. L. Baker, Professor of Concrete Technology at the College.

International Association for Bridge and Structural Engineering.

THE fourth congress of the International Association for Bridge and Structural Engineering will be held at Cambridge from August 25 to September 5 this year. The subjects to be discussed include: Loading of bridges and structures (influence of wind, earthquakes, etc.); Actual conditions for deformation (plasticity, creep, etc.); Safety of structures; Analytical methods of the theory of elasticity and plasticity; Numerical methods in applied statics; Other methods of calculation (approximate methods, relaxation, calculation of rupture loads, experimental statics, etc.); High-grade structural steel and light metals; Welding and welded connections; Steel building construction; Special erection methods; Composition of concrete; Influence of the preparation, transport, and placing of concrete on the design of structures; Properties of concrete (average tensile strengths and their variations); Effect of repeated and continuous loading (creep); Corrosion of concrete and reinforcement; Current problems of concrete and reinforced concrete; Progress in design and execution in prestressed concrete; Dynamic stressing and fatigue strengths. Full details may be had from the Secretariat of the Association, Swiss Federal Institute of Technology, Zurich.

A Mechanical Vibrator for Test Sieves.

It is an advantage when making a grading analysis of sand or soil to stack the sieves in tiers, pour the material into the top sieve, and agitate all the sieves at the same time, instead of manipulating each sieve by hand separately. The machine in *Fig.* 1 was developed for this purpose by British Railways (Western Region) and can take eight 8-in. diameter sieves or six 12-in. diameter sieves, a cover, and a collecting pan. It is of simple construction, has few moving parts, is quick in action, and has been in satisfactory operation for a year. The whole area of each sieve is used and wear of the sieves is thus reduced.

The sieves (not shown in *Fig.* 1) are held in an inner frame suspended from an outer frame by four 2-in. diameter helical springs 6 in. long. The tension in the springs is adjustable. Below the inner frame is a variable-speed 37-volt 160-watt electric motor, at both ends of the shaft of which is an eccentric weight. The weights are out of phase by 90 deg., and set up a compound vibration which shakes the particles of the material being tested around the sieves in a circular motion, while the sieves undergo also a vertical vibration. Both motions are simple harmonic vibrations, the maximum amplitude being about 2 mm., and, due to the difference at the end of the motor shaft, a rocking motion takes place in the vertical and horizontal planes.

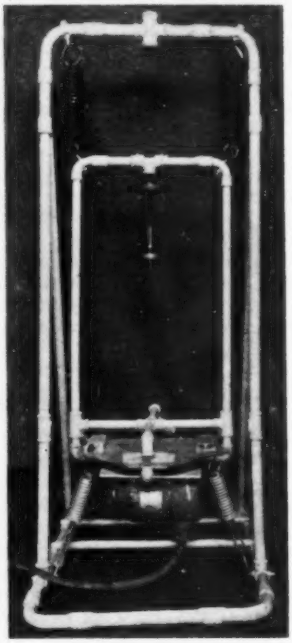


Fig. 1.—Sieving Machine.

To test the performance of the machine, 200 grammes of sand were sieved on the machine for varying times, and the weights retained on each sieve measured. The sample was thoroughly remixed before each sieving. Constant results were reached in about eight minutes, but after five minutes the results differed on the average by only 0·14 per cent. from the results obtained after 20 minutes. As results are generally required only to the nearest whole number, it is found that sieving for five to fifteen minutes, depending on the shape of the particles, gives results that are sufficiently accurate. The results are well within the limits specified in British standards. To achieve the same results by a trained operator using the manual method requires about 45 minutes.

A Substitute for Reinforcement Bars.

By N. A. DEWS.

THE saving in steel that could be effected by the more extensive use of reinforced or prestressed concrete has been referred to recently. A saving could also be made in the use of round bars for reinforcement by the careful selection of scrap material, bearing in mind that a rolled section is more useful as reinforcement than the steel section alone. For example, there are many miles of jubilee track (approximately No. 20 flat-bottom rails) which have been superseded by other types of transport and which have been abandoned. These could often be used as reinforcement.

Consider a bridge of 12 ft. effective span with a $10\frac{1}{2}$-in. deck slab and 2-in. cover to such rails weighing 20 lb. per yard, with a cross-sectional area of 1·97 sq. in.,

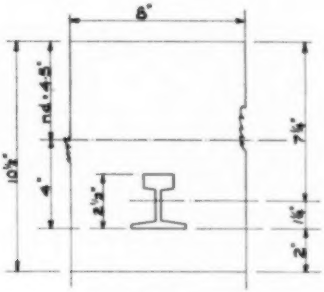


Fig. 1.

and a moment of inertia of 1·73. The weight per square foot would be: concrete, 126 lb.; rail, 6 lb.; road finish, 48 lb.; total, 180 lb.

Using the Ministry of Transport standard loading of 220 lb. per square foot live load and 2700 lb. "knife-edge" load, and with a dead load of 180 lb., the bending moment would be $\frac{1}{4} \times 2700 \times 12 + \frac{1}{8} \times 400 \times 12^2 = 15{,}300$ ft.-lb. If the rails are spaced at 8-in. centres (*Fig.* 1), $r = \dfrac{1\cdot97}{8 \times 7\cdot25} = 0\cdot034$.

$$n = \sqrt{2mr + (mr)^2} - mr = \sqrt{1\cdot02 + 0\cdot261} - 0\cdot51 = 0\cdot621.$$

$$nd = 0\cdot621 \times 7\cdot25 = 4\cdot5 \text{ in.}$$

Neglecting the concrete below the neutral axis,

$$I_c = \tfrac{1}{3} \times 8 \times 4\cdot5^3 + 15(1\cdot73 + 1\cdot97 \times 2\cdot75^2) = 243 + 249 = 492 \text{ in.}^4$$

The bending moment on a width of 8 in. is $\frac{2}{3} \times 15{,}300 = 10{,}200$ ft.-lb.

$$c = \frac{10{,}200 \times 12 \times 4\cdot5}{492} = 1120 \text{ lb. per square inch.}$$

$$t = \frac{10{,}200 \times 12 \times 15 \times 4}{492 \times 2240} = 6\cdot6 \text{ tons per square inch.}$$

The stress in the concrete is a little high so the depth will be made 11 in., giving $r = 0{\cdot}0318$, $nd = 4{\cdot}73$, $I_c = 578$, $c = 1000$ lb., and $t = 6$ tons, which is more acceptable. The deflection of the slab under full live load would be less than ¼ in., for which provision would be made in the shuttering. The shuttering should not be suspended from the rails, as the stress in the rails due to the load of the wet concrete alone would be about 9 tons per square inch, and this would be increased still further by the live load.

When rails or similar sections are used their shape will make the placing of the concrete more difficult than in the case of round bars, and careful consolidation, preferably with vibrators, is necessary particularly on the underside. It should not be assumed when using such material that accuracy is not so essential; the rails must be correctly placed and kept in position during concreting. It might also be an advantage to place alternate rails upside down in order to reduce the flat surface in contact with the concrete on the underside (the strength is not affected by this as the neutral axis is nearly at the centre of the depth of the rail). A cover of 2 in. is suggested as a precaution in view of the foregoing remarks, and light steel mesh or small diameter bars should be placed under the rails and securely wired to them and to an occasional larger diameter bar across the top of the rails.

It is important that the rails should be in reasonably good condition and they should therefore be carefully inspected and all rust, paint, oil, etc., removed with wire brushes or by light sand-blasting before use. If the rails are corroded allowance for this should be made in calculating the cross-sectional area, moment of inertia, etc., and allowance made in the maximum working stress assumed in the design; 6 tons per square inch is suggested as a reasonable working stress.

About half a ton of steel bars would be saved by using the rails and, although the total weight of steel may be greater than if round bars were used, no call would be made on the supply of bars.

Patent Beams and Posts.

LOCAL metallic linings are incorporated in concrete elements, and are retained solely by adhesion to the concrete, and two or more such elements are assembled with only their respective linings in contact whereby disintegration of the concrete is prevented. These linings are formed integrally with the concrete at the time of casting the latter. *Fig.* 1 shows crossing girders and beams (4, 5) provided with metal plates (7, 6) embedded in their faces at the crossing points, the girders having connecting plates (9) secured by bolts (8) passing through metal-lined sockets in the girders. *Fig.* 3 shows a metallic base (12) at the bottom of a post cast with the post and retained by adhesion, the base engaging a metallic lining on the member on which the post rests.—No. 603,719. C. A. Lefebvre. August 9, 1945.

FIG. 1.

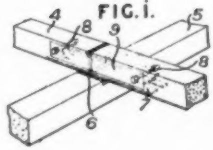
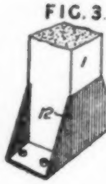


FIG. 3.



[Publication of patent specifications by the Patent Office is much in arrears due to the war.]

Three-story Dwellings of "No-fines" Concrete.

THE residential flats illustrated in *Fig.* 1 are the first three-story buildings erected in this country of no-fines concrete. The structure shown comprises 18 dwellings, and is part of a contract for 312 similar flats recently completed by Messrs. George Wimpey & Co., Ltd., for the Coventry City Council; Mr. D. E. E. Gibson, C.B.E., M.A., is the City Architect.

The "no-fines" concrete walls are load-bearing throughout, the thickness of the external and internal walls being 12 in. and 9 in. respectively. Below damp-proof course the walls are in 14-in. brickwork. The ground-floor raft is of concrete with indents to accommodate conduits. A duct of a size sufficient to accommodate all other services and drains is provided. Internal partitions are of clinker concrete. Suspended floors are of reinforced concrete cast in situ; chases 3 in. deep are formed in the walls to provide bearings for the floors.

The shutters (*Fig.* 2) comprised expanded metal fixed to open timber frames and were constructed, in general, in panels about 8 ft. wide; a few panels of a smaller width were also used. The panels were held in position by horizontal and vertical steel members designed to resist the pressures of the full head of concrete and other incidental loads applied during construction. Tests have shown that the expanded metal does not stick to the concrete if it is oiled (by spray) after every two uses.

The internal shutters were erected in two heights. The lower lift, consisting of eight panels, was first erected up to second-floor level. A working platform was then added, from which the internal shutters for the top story were erected. The steel reinforcement was then placed in position, and cores to form window and other openings were bolted to the internal shutter. The external shutters were then erected to the full height of about 26 ft., and the internal and external shutters were bolted together by means of tie-bolts passing through the horizontal steel walings. The top working platform, complete with handrails and toe-boards, was then lifted into position. The walls were concreted from ground level to gable top in one lift. A day's concreting consisted of a length of 28 ft. of the structure, including the longitudinal party wall, and comprised 110 cu. yd. of concrete.

Fig. 1.—Residential Flats Built of "No-fines" Concrete.

The suspended floors were concreted on centering constructed of light alloy channels bolted together side by side and propped from the underside.

The aggregate for this type of concrete is between ¾ in. and ⅜ in. size, and it is specified that at least 95 per cent. must pass a ¾-in. sieve and that not more than 10 per cent. shall pass a ⅜-in. sieve; it is preferred that all the material should pass a ¾-in. sieve and that not more than 5 per cent. should pass a ⅜-in. sieve. The aggregate is in a damp condition when used. Normally the yield of concrete is equal to the volume of the aggregate. The proportions are 12 cu. ft. of aggregate

to 135 lb. of cement to make a batch for a 12S mixer; it is unwise to overload the drum of the mixer, as this may result in non-uniform coating of the aggregate with cement. In order that the water may be evenly distributed, part of the mixing water is put into the drum before the materials and the remainder when the contents of the skip are in the drum. The period of mixing is at least one minute with the drum rotating at a speed of 17 revolutions a minute. The consistency is such that all the particles of aggregate are evenly coated with cement but the cement-grout does not drain through the aggregate. The water-cement ratio is 0·38 to 0·4, that is 4¼ to 4½ gallons of water to 1 cwt. of cement including the surface moisture in the aggregate. In a batch comprising 135 lb. of cement the total quantity of water required is 5¼ to 5½ gallons, of which about 2 gallons are contained as surface moisture in the 12 cu. ft. of aggregate and 3¼ to 3½ gallons are added. Very little rodding is necessary except to push the concrete under window and other openings. Dense 1 : 2 : 4 concrete is used for the beam at the eaves and around the chimneys.

The walls are rendered on the outside and plastered internally after they have dried and the shrinkage has taken place. The backing coat for the rendering generally comprises 1 part cement, 1 part lime, and 6 parts of sand; in cold and wet districts the proportions are 2 : 1 : 9.

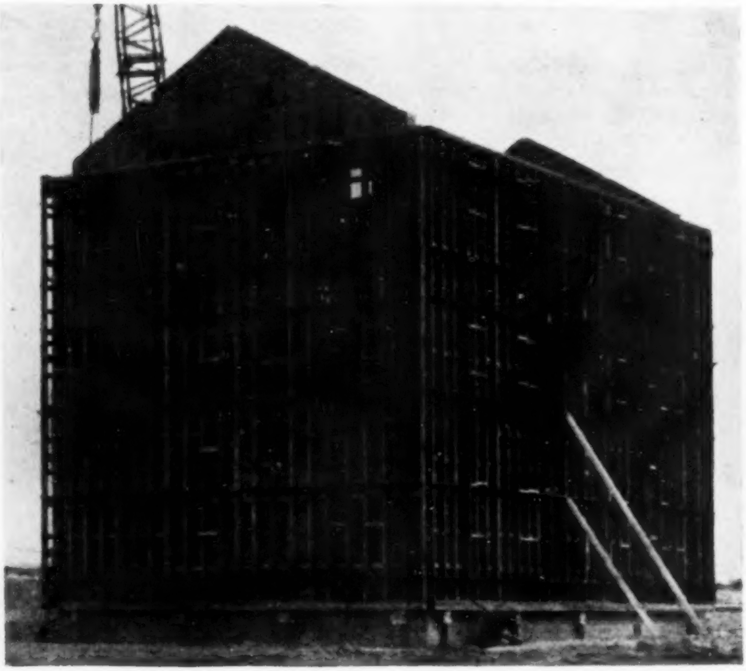


Fig. 2.—Shuttering for "No-fines" Concrete.

Indentations are left in the no-fines concrete for nailing strips formed of foamed-slag mortar. The mixture (by volume) recommended for the foamed-slag mortar, based on the results of nail-holding tests, is as follows: 1 part dry slaked lime, 2 parts cement, 2 parts fine foamed slag, and 2 parts coarse foamed slag.

A Portable Plant for Loose Cement.

A SMALL portable plant for handling loose cement suitable for sites and precast concrete products factories using up to 3 tons of cement per hour is illustrated in *Figs.* 1 and 2. The principal equipment is an air-compressor, a receiving bin, and a dispensing hopper. Cement is discharged from lorries into the receiving bin from which it is carried in a stream of air to the dispensing hopper from which the cement is discharged into containers or batch-weighers.

The receiving bin, which stands on the ground or on the floor of a factory, holds about 8 tons of cement (density 90 lb. per cubic foot) and comprises a steel frame on skids, wooden sides and top, and two steel-plate outlet hoppers. The sides and top are lined inside and outside with waterproof felt to prevent condensation. Part of the top is hinged to allow the cement to be discharged directly into the bin. When the lid is closed and clamped the bin is airtight. At the bottom of each outlet hopper there is a tubular-valve in the air-line. Manual operation of the valve permits the cement to be sucked into the air-stream and this is assisted by slight aeration through the medium of air pokers.

Fig. 1.—Portable Plant for Loose Cement.

The compressed air is supplied from an ordinary compressor at a pressure of 90 lb. to 100 lb. per square inch. The amount of free air required is 100 cu. ft. per minute if 3 tons of cement per hour are blown a horizontal distance of 60 ft. and a vertical distance of 15 ft. If 1½ tons per hour are to be blown 10 ft. horizontally and 5 ft. to 10 ft. vertically, the amount of free air required is about

60 cu. ft. per minute. The compressed air is passed through a cooling grid and a filter to remove moisture and oil before being passed through the control valves to the two outlet hoppers. Two small branch pipes supply air to an external vibrator on the outlet hoppers and to an aerating jet which facilitate the flow of cement.

From the receiving bin the cement is blown either directly to the dispensing hopper or to an intermediate storage silo. The cylindrical dispensing hopper has a conical bottom and contains 10 cu. ft. of aerated cement of a density of 60 lb. per cubic foot. It is constructed of steel tube and plate, and has adjustable bases. The outlet valve has an instantaneous cut-off. The cement can be discharged directly into a batch-weigher or other container, or a hose can be attached to the outlet to reduce the dust nuisance in windy weather.

If intermediate storage is required, a mobile steel silo of 12 tons capacity (at 60 lb. per cubic foot) is supplied. The silo is filled from the receiving bin, and is similar in construction to the receiving bin but is on a chassis mounted on a pair of detachable wheels with pneumatic

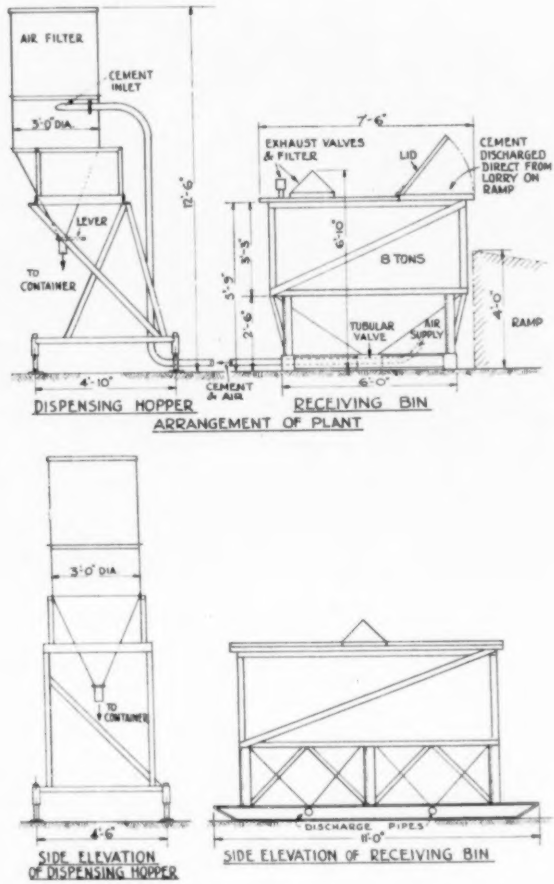


Fig. 2.—Details of Loose Cement Plant.

tyres. To ensure that cement is used in the order it is delivered, the plant is arranged so that if a silo is provided the cement passes from the receiving bin to the silo and from the silo to the dispensing hopper and not directly from the receiving bin for fresh cement to the dispensing hopper.

The equipment is supplied by Road Machines (Drayton), Ltd.

A Code of Practice for Chimneys.

BRITISH Standard Code of Practice [131.101 (1951)], "Flues for Domestic Appliances Burning Solid Fuel" (price 5s. from the British Standards Institution), deals with the design and construction of chimneys of brick, masonry, cast-in-situ concrete, precast concrete, hollow blocks, metal, and asbestos-cement. The following notes apply to cast-in-situ and precast concrete chimneys which may be either plain or reinforced. Where the walls of the building are lightweight concrete, the chimneys may be constructed of the same material if liners are used to protect the concrete against heat and the risk of staining and disintegration due to condensation. Reinforcement should have a cover of dense concrete of not less than 1 in. from any external face and from the face of a flue. Reinforced concrete chimneys should be designed in accordance with CP. No. 114.

The best aggregates for cast-in-situ plain dense concrete chimneys are stated to be crushed brick, slag, or crushed sandstone as these materials produce better heat-resistant concrete than do flint or quartz. To reduce the effects of shrinkage, the mixture of plain concrete should be about 1 : 2½ : 5, but if greater strength is required for structural resistance to the effects of wind the mixture should be 1 : 2 : 4. If the stack has a height not greater than seven times its least width, no investigation need be made for stability against wind, but if this ratio is exceeded the cross section of the stack should be such that the tensile stress in the plain concrete does not exceed 50 lb. per square inch when the exposed part is subjected to the wind pressure specified in the Code of Functional Requirements of Building, Chapter V, "Loading". Sudden changes in cross section should be avoided as they tend to cause cracks due to shrinkage, and thermal expansion and contraction. The soffit of cantilevers supporting cast-in-situ plain concrete chimneys should form an angle with the vertical not greater than 30 deg.; if a greater angle is required, the projection should be reinforced.

PATENT.

PATENT. The Proprietors of British Letters Patent No. 608,619, dated 25th March, 1942, "Reinforced Concrete Pipes and Joints therefor", are desirous of disposing of the Patent rights or of negotiating for the granting of Licences to work thereunder. All enquiries should be addressed to MEWBURN, ELLIS & Co., 70-72 Chancery Lane, London, W.C.2.

Protection Against Nuclear Radiation.

In our last number we gave some notes on the nuclear research laboratory recently built at Liverpool University to the designs of Mr. William Holford, M.A., and Professor H. W. B. Skinner, F.R.S., by Messrs. Bovis, Ltd. We have now received from the University the following note on the calculation of the thickness of concrete required to give protection against the radiation of neutrons.

The energy of neutrons produced by the synchro-cyclotron at Liverpool University will be up to a maximum energy of 400 million electron volts. The penetrating power of neutrons through concrete increases rapidly with the neutron energy, and a great thickness of concrete is required to reduce the radiation outside the machine.

The Berkeley Laboratory group has measured the attenuation of high-energy neutrons in concrete, and found that for neutrons produced by a beam with a proton energy of 350 million electron volts the half-thickness (in the forward direction) is 18 in. structural concrete. For 400 million electron-volt protons from the cycloton this should be increased approximately in the ratio of proton energies to 21 in. The measurements also show that, for materials of not too high an atomic weight, the thickness required varies inversely as the density. The half-value thickness for iron is 7·1 in. The most economical shield should, therefore, be a combination of steel and concrete.

It is assumed that a beam of $\frac{1}{10}\ \mu A$ protons will produce neutrons from a target or from the top or bottom pole tips near to the edge. The speed of the protons will be reduced as they penetrate the iron and a nuclear collision resulting in the emission of a neutron may take place at any point along this path. The energy of the neutron emitted will depend on the proton energy at the moment of encounter and the angle at which the neutron is emitted. A reasonable estimate of the

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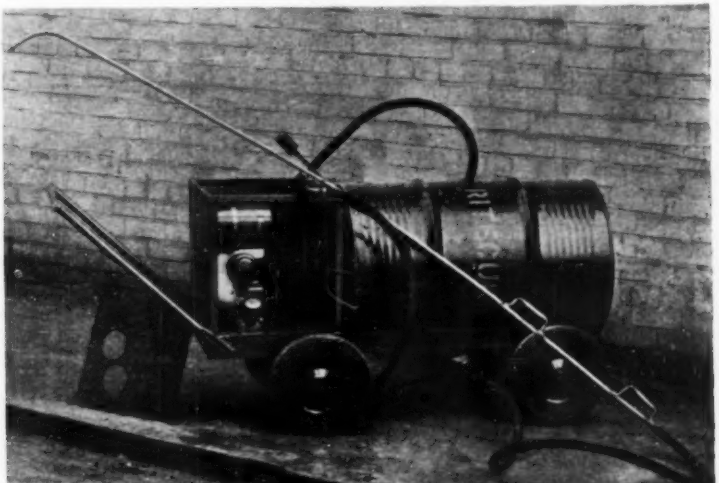

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number of neutrons which might be emitted at an angle θ to the plane of the orbit in a direction tangential to it is

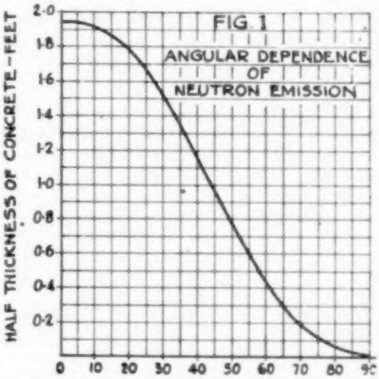
$$3 \times 10^{10} F(\theta) \text{ per solid angle.}$$

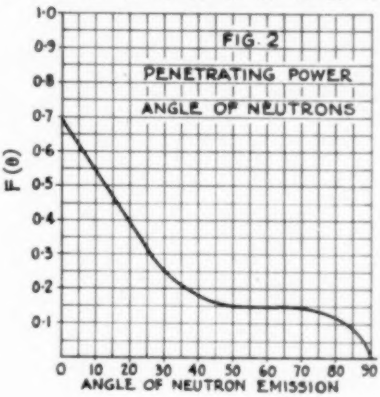
The Berkeley group has established a value for $F(\theta)$ for 90 million volt neutrons as shown in *Fig.* 1. The energy of the neutrons, which are emitted at an angle θ, was calculated from

$$E_n = 2 \cos^2 \theta \left[\frac{2}{E_p} + 1 - \cos^2 \theta\right]^{-1},$$

obtained from the conservation laws assuming that the neutron is produced in a free nucleon-nucleon collision. The neutron and proton energies E_n and E_p are given in units of the rest-mass energy of 940 million electron-volts. Since the neutron energy decreases with increasing θ, the penetrating power of the neutrons will decrease also. A reasonable assumption is that the half-thickness $\delta(\theta)$ for neutrons emitted at an angle θ will be proportional to the neutron energy $E_n(\theta)$ at this angle. This was the basis of *Fig.* 2.

The calculation of the number of neutrons (N) per square centimetre per second, at a distance r ft. along a line drawn in a plane tangential to the orbit, which passes through D ft. of concrete or its equivalent, and which makes an angle





θ with the horizontal, may be made by using

$$N_{\bullet} = 3 \times 10^{7} \frac{F(\theta)}{r^2} \text{ exp. } \left[\frac{-0{\cdot}693D}{\delta(\theta)}\right].$$

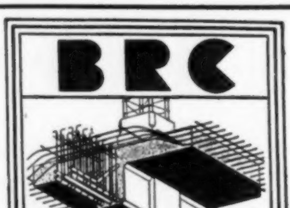
Where the neutrons pass through materials other than concrete the value of D is computed by multiplying by a suitable factor the thickness in feet of each of the materials passed through and summing these products. The thickness factors are approximately as follows for various materials: Sand, 0·7; gravel, 0·8; concrete, 1·0; steel punchings, 2·0; steel, 3·2. It may be seen that in a typical case in which $r = 40$ ft., $\theta = 15$ deg., and $D = 17$ ft., the neutron flux will be 12 neutrons per square centimetre per second. The safe tolerance level of high-energy neutrons is about 10 per square centimetre per second for eight hours a day.

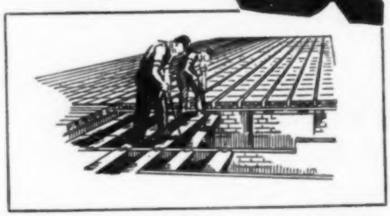
Bars for Prestressed Concrete.

Two brochures issued by McCalls Macalloy, Ltd., Templeborough, Sheffield, in connection with the Lee-McCall system of prestressed concrete give much useful practical information on the manufacture of prestressed concrete, in addition to information related specially to the Lee-McCall system. Brochure No. 1 describes the methods of making high-strength concrete, and tables are given from which proportions and water contents can be selected to give required strengths with different classes of aggregate. Brochure No. 2 gives notes on methods of casting and curing concrete, and on prestressing with steel bars.

Professional Announcement.

Mr. C. J. Pell, consulting engineer, of 4 Manchester Square, London, W.1, has taken into partnership Mr. M. M. Khan and Mr. F. S. Rowe, who are now practising as C. J. Pell & Partners.





MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 3d. a word: minimum 7s. 6d. Situations Vacant, 4d. a word: minimum 10s. Other miscellaneous advertisements, 4d. a word: 10s. minimum. Box number 1s. extra. The engagement of persons answering these advertisements is subject to the Notification of Vacancies Order, 1952.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT.

SITUATIONS VACANT. Structural engineering designer/draughtsmen required in Designs Branch by Air Ministry Works Department. Applicants should have had several years' experience in the design and detailing of reinforced concrete or structural steelwork. The appointments will normally be in London. Salaries are in ranges up to £675 per annum with starting pay dependent upon age, qualifications and experience. Applications, stating age, qualifications, previous appointments (with dates), should be sent to Air Ministry Directorate General of Works, C.22 (W.9), Bush House, S.E. Wing, Strand, London, W.C.2, from which address further details may be obtained.

SITUATIONS VACANT. Reinforced concrete designers wanted for Southern Rhodesia and Union of South Africa. Candidates should have had at least 5 years' experience of competitive designing. Free passages. Salary according to experience and qualifications. Details in confidence to Box R13, c/o 95 Bishopsgate, London, E.C.2.

SITUATION VACANT. Experienced junior draughtsman required by consulting engineer in the Sutton district of Surrey. Age 20–30. Experience in detailing reinforced concrete essential, and preferably structural and welded steel, with stressed concrete. The work is interesting and varied, largely heavy machine foundations and allied structures. Salary according to age and experience. Good prospects in an expanding business. Box 2540, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Outside engineer with good background in reinforced concrete structures. Quick and accurate at setting out. House with modern convenience available. Preferably a car owner. This is an excellent opportunity for a keen, hard-working engineer in the thirties. Box 2541, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Consulting Engineer, Westminster, requires designer-draughtsman with first-class experience in structural steelwork and/or reinforced concrete for responsible position. High salary and good prospects for suitable applicant. Write in confidence stating age, qualifications, and full details of experience. Box 2542, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Assistant to development engineer required for large precast concrete factory. The work will entail the general control of quality testing and design, and experimental manufacture of a variety of products, mainly prestressed. Applicants should possess or be studying for the National Certificate. 5-day week. Salary commensurate with experience. Write Box 011, c/o Walter Judd Ltd., 47 Gresham Street, London, E.C.2.

SITUATION VACANT. British Railways (London Office) require draughtsman skilled in the design of reinforced concrete bridges and structures, and preferably having a working knowledge of prestressed concrete design. Good opportunity for permanency and promotion. Apply to Civil Engineer's Office, Paddington Station, London, W.2.

SITUATION VACANT. Reinforced concrete designer. Simon-Carves, Ltd., have a vacancy in their London drawing office for a reinforced concrete designer with sound experience of industrial work. The firm specialises in the design and erection of power stations, coal preparation, and chemical plant, and offers a wide range of interesting work. Salaries are above average and a pension scheme is in operation. Working conditions and scope are good. Ministry of Labour permission will be necessary before engagement. Apply to Personnel Dept. (Ref. AD.25), Simon-Carves, Ltd., Cheadle Heath, Stockport.

SITUATION VACANT. CITY OF OXFORD.—Applications are invited for the appointment of assistant engineer in the City Engineer's Department at a salary according to qualifications and experience, within Grades I to V of the A.P.T. Division of the National Scales, namely: A.P.T.I., £440—£485 per annum; A.P.T.II, £470—£515 per annum; A.P.T.III, £500—£545 per annum; A.P.T.IV £530—£575 per annum; A.P.T.V, £570—£620 per annum. Candidates should have had experience in reinforced concrete detailing and design. Previous Local Government experience is not essential. The appointment will be superannuable, terminable by one month's notice on either side, and subject to the National Conditions of Service. The selected candidate will be required to pass a medical examination. Applications, giving full details together with the names of three persons to whom reference may be made, should reach the City Engineer, Town Hall, Oxford, not later than Monday, 21st April, 1952.—Harry Plowman, Town Clerk, Town Hall, Oxford.

SITUATION VACANT. Trollope & Colls, Ltd., require junior engineer with about two years' experience of concrete design and detailing. Apply to Deputy Chief Engineer, 41 Great Queen Street, London, W.C.2.

SITUATIONS VACANT. Reinforced concrete detailers required in Victoria office of civil engineering contractors. Permanent and progressive appointment for suitable applicants. Box 2544, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Civil engineer with first-class experience in design of heavy foundations and all types of reinforced concrete structures required for senior appointment with consulting engineers in Newcastle-upon-Tyne area. Applications are also invited for several posts for designer-detailers from applicants having previous experience in design and detailing of similar works. Salaries commensurate with qualifications and experience. Apply, giving particulars of age, experience, and salary required, to Box 2545, Concrete and Constructional Engineering, 14 Dartmouth Street London, S.W.1.

SITUATIONS VACANT. The British Reinforced Concrete Engineering Co., Ltd., require several qualified designers with specialist experience for their Stafford, London, Bristol, Glasgow, and Newcastle-upon-Tyne offices. Five-day week and staff pension scheme. Apply to B.R.C. Engineering Co., Ltd., Stafford.

SITUATIONS VACANT. The Trussed Concrete Steel Co. Ltd., Truscon House, 35–41 Lower Marsh, London, S.E.1, require additional staff in their London and Manchester design offices: (a) Designer-Detailers (age 25 or over), (b) Detailer-Draughtsmen (age 20 or over). Previous good experience in reinforced concrete drawing office is important. Five-day week and pension scheme. Apply in writing to the above address giving full particulars of age, education, and previous employment.

SITUATION VACANT. Deputy to chief engineer in Manchester office of reinforced concrete specialists. Must be competent competitive designer, and capable of effective supervision of drawing office staff. Address applications in writing stating age, salary required, and particulars of career to date, in confidence, to Box 2546, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

SITUATION WANTED.

SITUATION WANTED. Civil engineering designer-manager, expert on precast and prestressed concrete, A.M.I.C.E., M.I.Struct.E., many years' practice, first-class references, wants position or other connection with building or civil engineering contractors who are keen on this modern method of construction. Box 2543, Concrete and Constructional Engineering, 14 Dartmouth Street, London, S.W.1.

WANTED.

WANTED. 7/5 concrete mixer. Please give full details, price, when purchased, etc., to Blakely (Hope), Ltd., Bridge Works, Hope, near Sheffield.

FOR SALE.

FOR SALE. Sacks, bags, and curing cloths for sale. You want the best type and quickest delivery. Write John Braydon, Ltd., 26 The Highway, London, E.1. Telephone: ROYal 1044.

FOR SALE. Tonnage of Punched Strip, ¼" to ⅛" thick, for reinforcement. Pike Bros., Private Sidings, Colnbrook, Bucks. Telephone 175.

FOR SALE. Large stock of close joint and SD tubular steel hoops and runners ex several hundreds WD vehicle canopy frameworks. Sizes approximately—hoops, 6 ft. 9 in. wide by 4 ft. 8 in. high; runners, 9 ft. to 12 ft. long, chiefly 1¼ in. and 1½ in. o/d, 14s. gauge. Woodfield & Turner, Burnley. Telephone 3065.

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